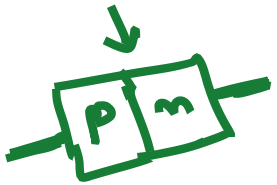
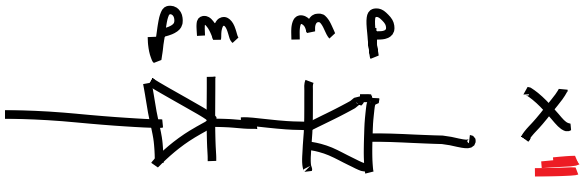
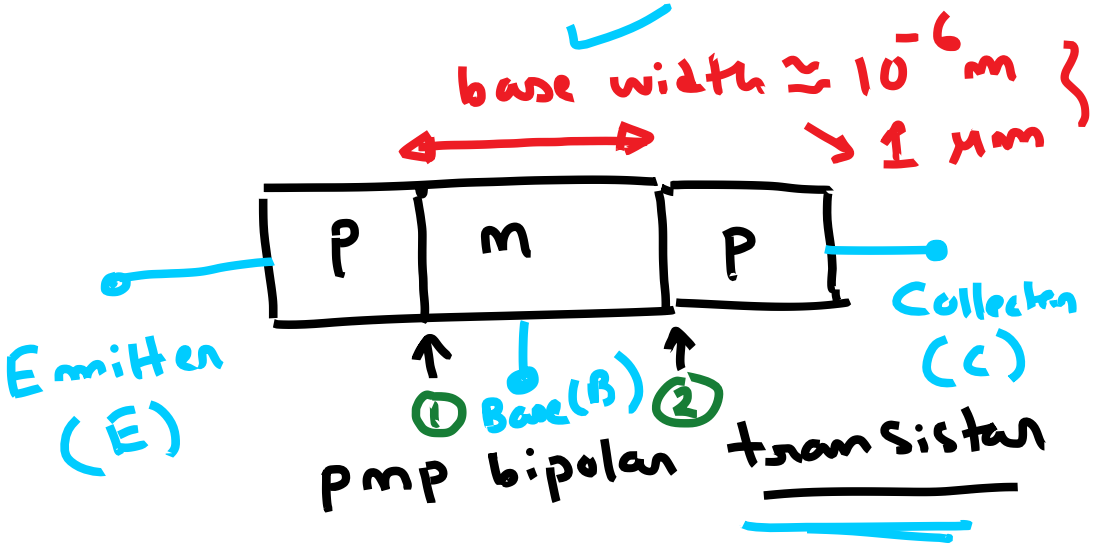
Bipolar Junction Transistor (BJT)

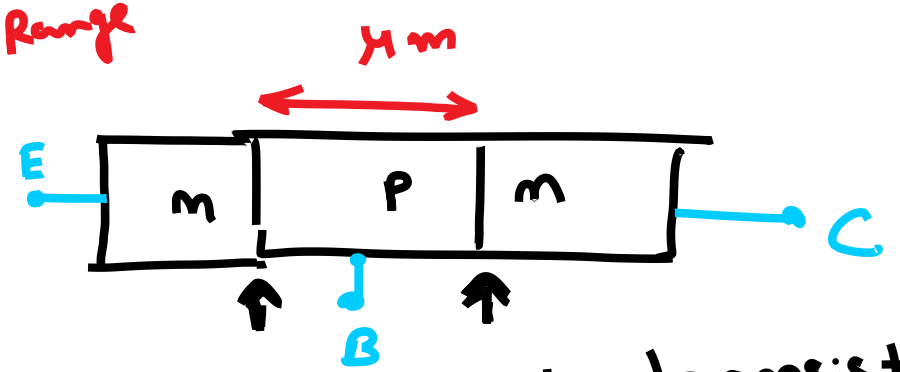


electrons and holes



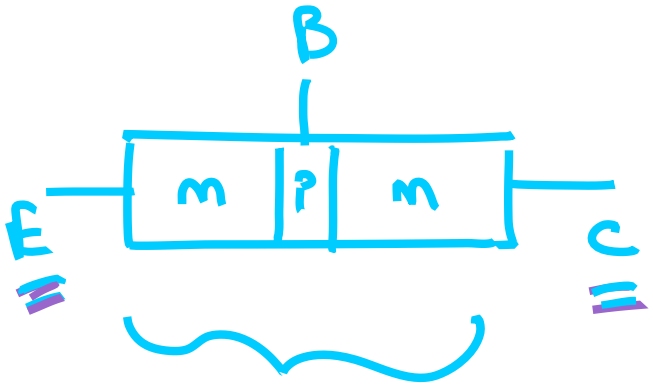


pnp bipolar transistor



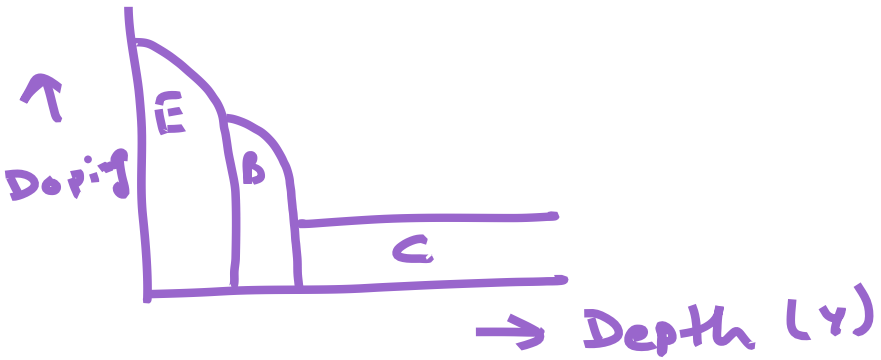
n-p-n bipolar transistor.

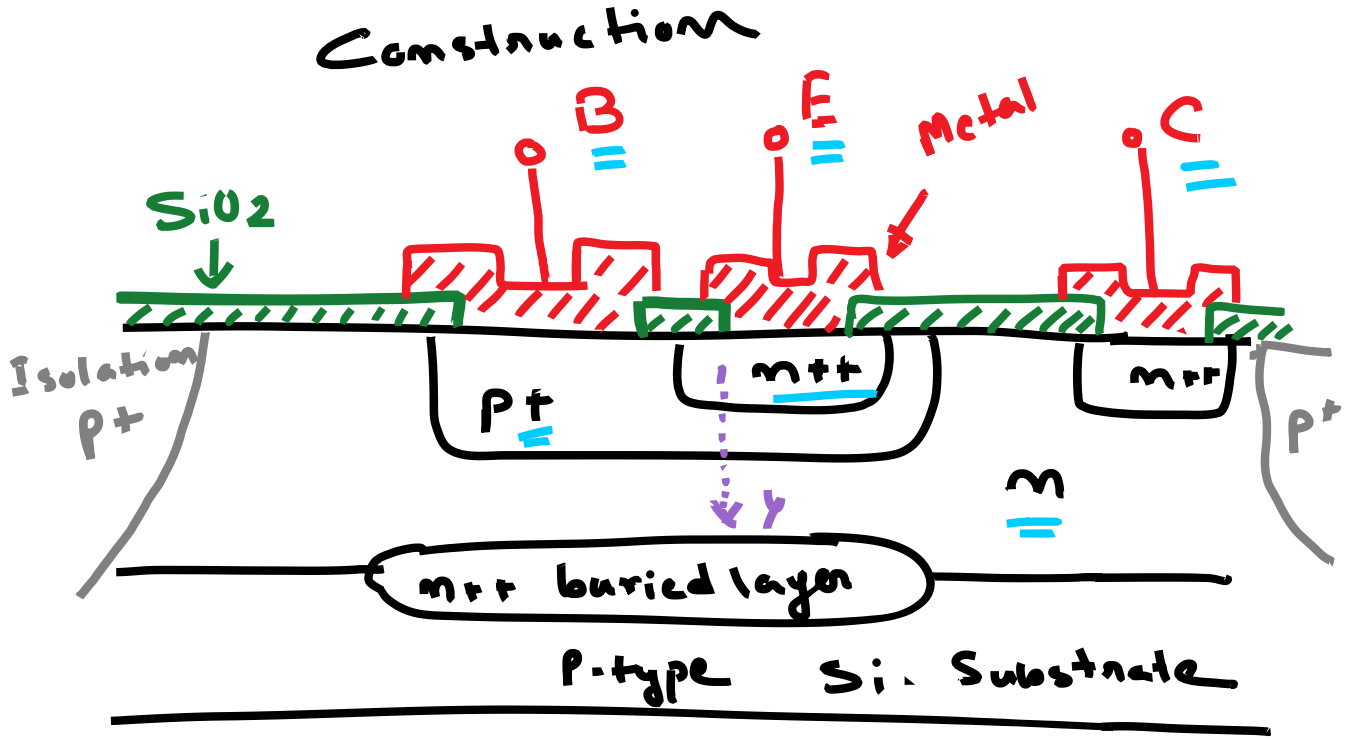
Bipolar Junction Transistor (BJT)



① Area of E & C

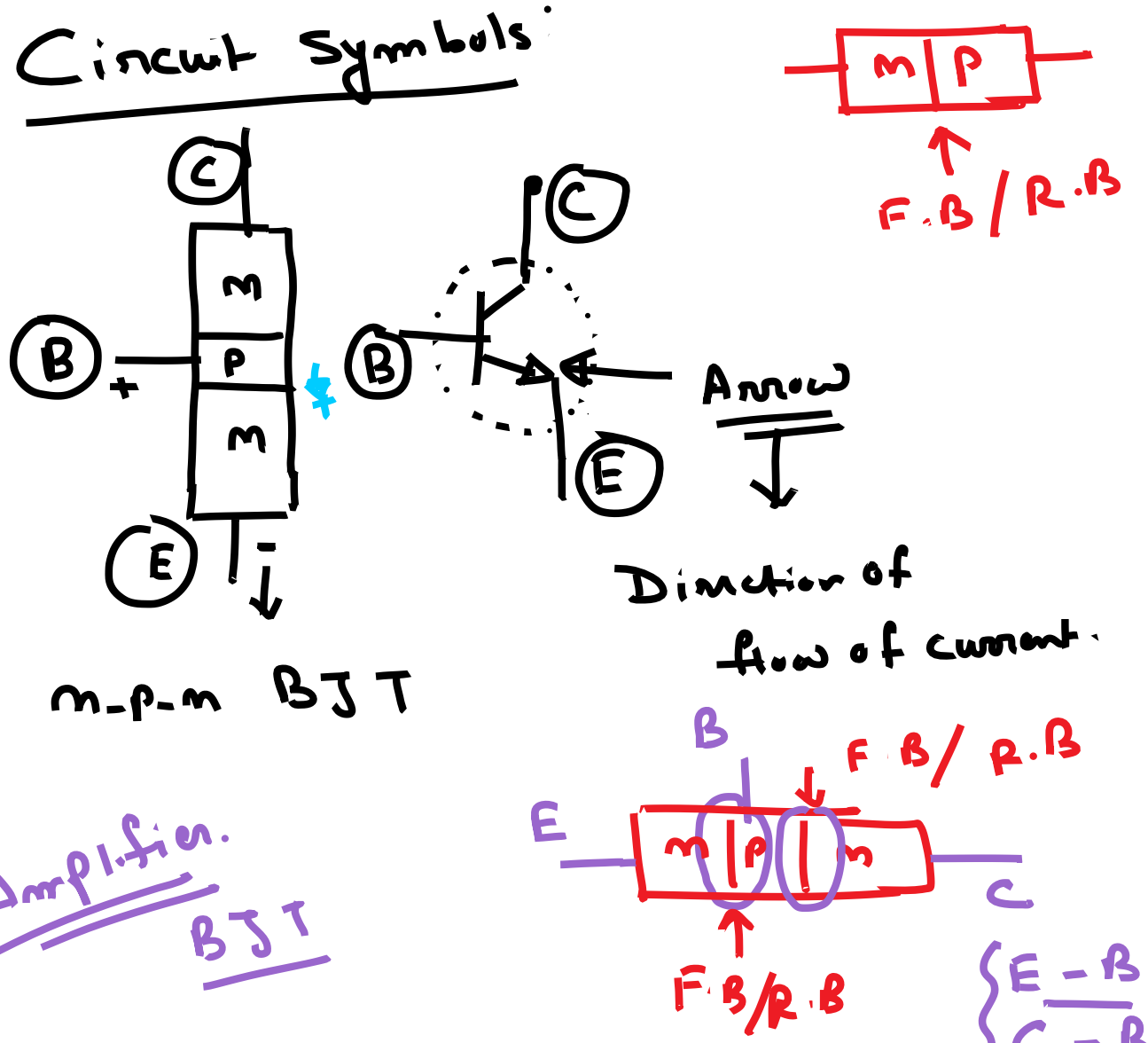
② Doping of E & C

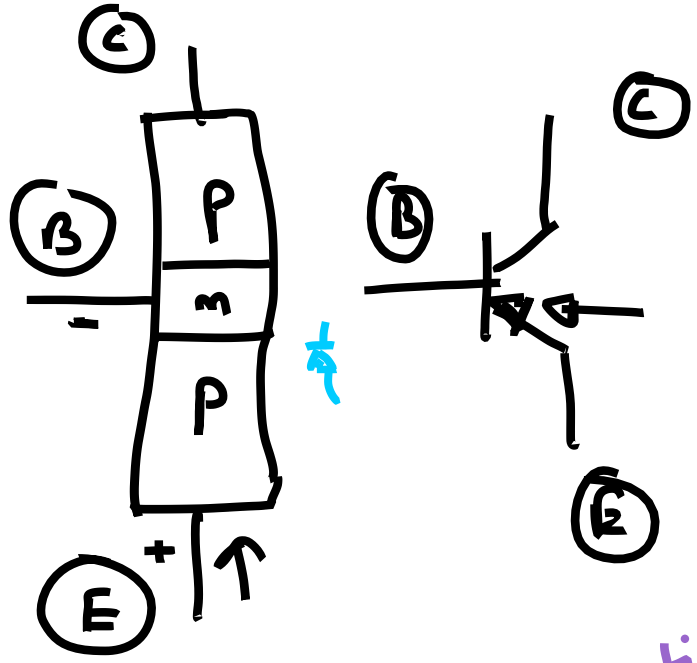




Cross. Sectional Schematic of BJT

Bipolar Junction Transistor (BJT)





Amplifier.

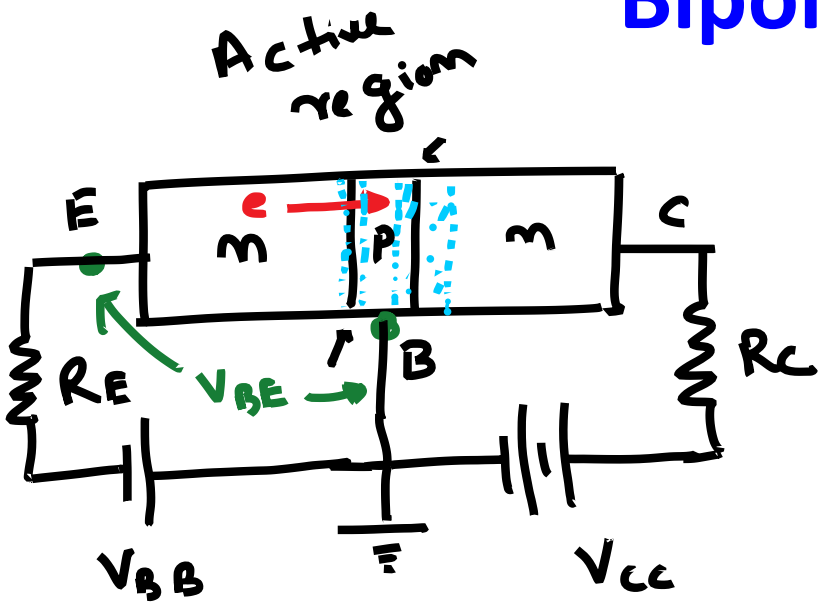
BJT

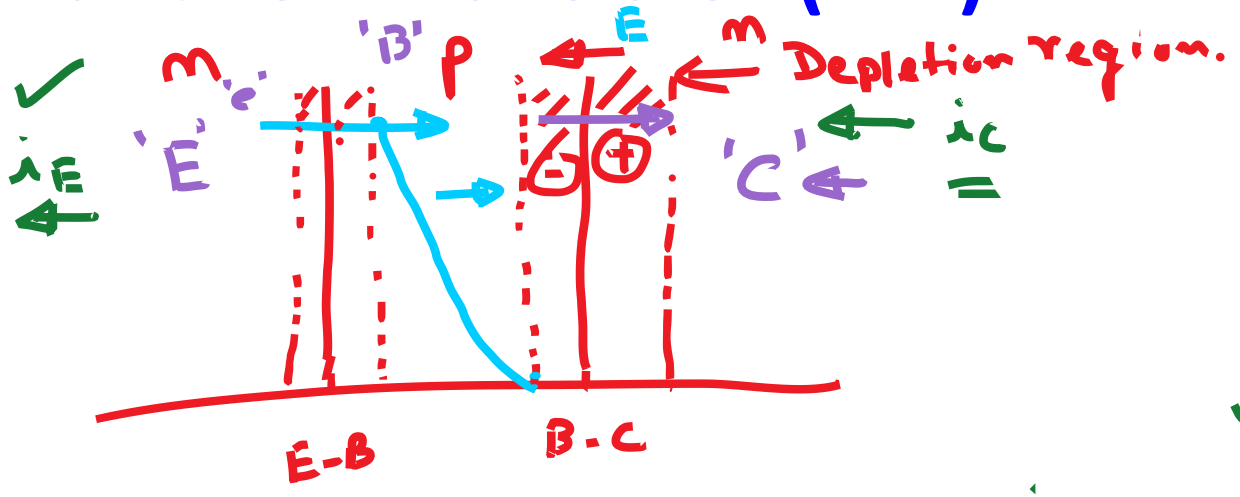
Amplifier

forward active operating mode / active region

$\begin{cases} E-B \text{ Junction} \rightarrow \text{Forward bias} \\ C-B \text{ "} \rightarrow \text{Reverse bias.} \end{cases}$

Bipolar Junction Transistor (BJT)





Emitter current

$$i_E = I_{EO}\left[\exp\left(\frac{V_{BE}}{V_T}\right) - 1\right]$$

$$i_E = I_{EO}\exp\left(\frac{V_{BE}}{V_T}\right)$$

I_{EO} → 10^{-12} A to 10^{-15} A

Collector current

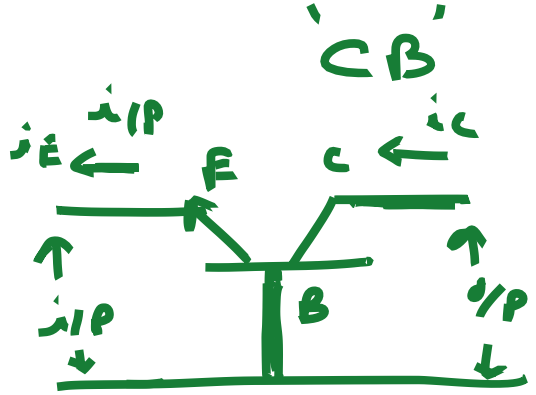
$$i_C \propto \exp\left(\frac{V_{BE}}{V_T}\right)$$

$$i_C \propto i_E$$

$$i_C = \alpha\, i_E, \quad \alpha = \frac{i_C}{i_E}, \quad \alpha < 1$$

α → common base current gain

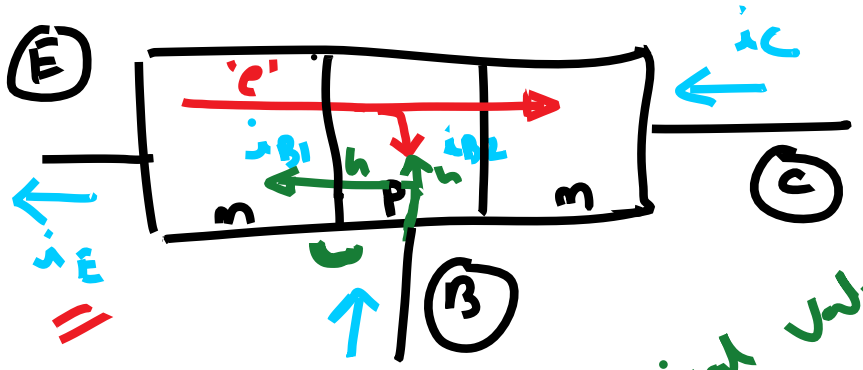
$\alpha \approx 1$



Bipolar Junction Transistor (BJT)

Base current

$i_E = i_B + i_C$



typical value

$50 < \beta < 300$

'β' fixed

$i_{B1} \propto \exp\left(\frac{V_{BE}}{V_T}\right)$

$i_{B2} \propto \exp\left(\frac{V_{BE}}{V_T}\right)$

$i_B = i_{B1} + i_{B2}$

$i_B \propto \exp\left(\frac{V_{BE}}{V_T}\right)$

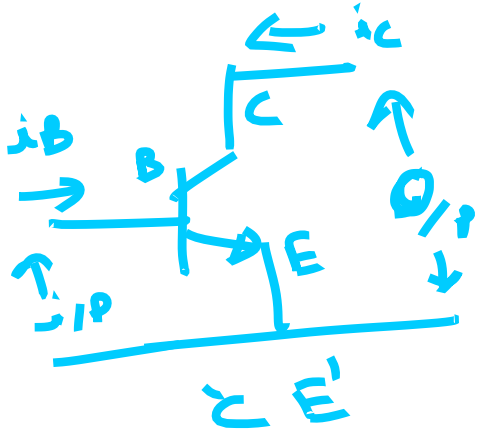
$i_C \propto \exp\left(\frac{V_{BE}}{V_T}\right)$

$i_C \propto i_B$

$i_C = \beta i_B$

β ← * ← current gain

emitter



Common emitter current gain $= \frac{i_C}{i_B} = \beta$

Bipolar Junction Transistor (BJT)

$i_E = i_C + i_B$ ✓

$= \beta i_B + i_B$

$\Rightarrow i_E = (1+\beta) i_B$ *

$i_C = \beta i_B$; $i_B = \frac{i_C}{\beta}$ ✓

$\beta = 100$,

$\alpha = \frac{100}{101}$

$\simeq 0.99$

$i_E = \frac{\beta+1}{\beta} i_C$ ← A

$i_C = \frac{\beta}{1+\beta} i_E$; $i_C \propto \alpha i_E$

$\alpha = \frac{\beta}{1+\beta}$; $\beta = \frac{\alpha}{1-\alpha}$